Ultrafast Terahertz Spectroscopy of CMR Manganites

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Ultrafast optical techniques can serve as an important tool in elucidating quasiparticle behavior in complex materials since the dynamics can be temporally resolved at the fundamental timescales of electronic and nuclear motion. We have extended these time-resolved techniques to probe ultrafast dynamics in the far-infrared (~0.2-2.5 THz) using time-domain terahertz spectroscopy with a view towards probing low energy excitations of doped transition metal oxides and other complex materials. Specifically, we measure the optically induced changes in the far-infrared conductivity with picosecond resolution. For $La_{0.7}Sr_{0.3}MnO_3$, $La_{0.7}Ca_{0.3}MnO_3$, and $Nd_{0.7}Sr_{0.3}MnO_3$ thin films a two-component decrease in the conductivity is observed below T_c and a fast increase is observed above T_c. These measurements demonstrate the ability to separate and characterize spin and phonon dynamics below T_C [1], as well as indicate the presence of photo-assisted hopping of small polarons near T_C. Commensurate with the optically induced decrease in the far-infrared conductivity, we observe an increase in the reflectivity at 1.5 eV with nearly identical dynamics. For a decrease in the far-IR conductivity there is a commensurate increase in the absorption at 1.5 eV (and vice versa), indicative of a dynamic spectral weight transfer consistent with the temperature dependence of the optical conductivity [2,3].

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